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A METHOD OF POLISHING A WAFER OF MATERIAL

The present invention relates in general manner to treating semiconductor materials for use in microelectronic and/or optoelectronic applications.

More precisely, the invention relates to a method of polishing a wafer of material, implementing at least one polishing step using an abrasive based on diamond particles in suspension in a solution.

The invention also relates to multilayer structures obtained by bonding together two or more wafers, at least one of the wafers being a wafer of material that has been polished by such a method.

The invention may be applied in particular:

- either to wafers of material purchased directly in the trade and having surface properties that are not compatible with molecular bonding;
- or else as surface reconditioning treatment after removal and transfer of a thin layer.

BACKGROUND OF THE INVENTION

It is specified that the materials concerned by the invention are preferably polar materials.

Polar materials are defined as being materials made up of different types of atom, and presenting, when the material is in wafer form, a face with which a first type of atom is flush, while the opposite face of the wafer has a second type of atom flush therewith.

The materials may also be semiconductor materials.

Thus, for example, semiconductor polar materials include SiC, GaN, and AlN, for example.

The description given below of an implementation of the invention relates to a particular one of these materials: SiC.

Methods of the above-mentioned type are already known.

Such methods should enable a silicon carbide surface to be obtained which presents, simultaneously:

- good planeness. This is because such wafers of silicon carbide are typically used subsequently for bonding to another wafer by molecular bonding. It is important that the two surfaces which are brought together to achieve such molecular bonding to be perfectly plane - typically these surfaces should present departures from planeness that do not exceed values of the order of few microns;

- roughness that is small as possible. This second objective is also necessary in order to be able to achieve molecular bonding. In semiconductor material applications of the type mentioned in the beginning of the present patent application, it is typically desired to obtain surface roughnesses not exceeding a value of about 0.5 nanometers (nm) in root mean square mean (rms) value.

A specific constraint associated with silicon carbide (SiC) is that the material presents extremely high mechanical hardness.

In addition, the crystal structure of this material is anisotropic and oriented. Amongst other things, this means that the two opposite faces of an SiC wafer do not present the same crystal structure, one of the faces presenting silicon atoms while the opposite face presents carbon atoms.

These two characteristics make polishing SiC wafers extremely difficult, particularly when qualities of planeness and roughness such as those mentioned above are desired.

As mentioned above, methods are known of the type mentioned in the beginning of this specification which make use of at least one step of polishing the surface of an SiC wafer by means of a diamond abrasive (i.e. an abrasive based on diamond particles in suspension in a liquid).

Such polishing generally makes it possible to obtain surfaces with good planeness.

Nevertheless, the use of diamond particles leads to damage to the polished SiC surface.

Because of friction on the SiC surface, abrasive diamond particles generate crystal defects in a zone of the SiC wafer which becomes work-hardened due to the polishing.

It is then necessary to proceed with successive polishing operations using diamond particles of decreasing diameter so as to eliminate in succession the work-hardened zones as generated by each preceding polishing step.

An example of such a method is to be found in US patent document No. 5 895 583.

After the successive mechanical polishing steps, it is also necessary to perform ionic surface etching in order to eliminate the few hundreds of nm of surface thickness left defective due to the last polishing operation.

In addition, at the end of polishing operations of those types, scratches are still to be observed in the surface of the SiC wafer.

Such scratches must be eliminated by an additional step of chemical and mechanical polishing (CMP).

With SiC, such CMP polishing is difficult to implement since the polished surfaces present low chemical reactivity with respect to this type of polishing (in particular when compared with the materials that are usually polished by CMP, such as silicon, GaAs, or InP).

As a result, during the final operation of CMP polishing, the removal rate from the surface to be treated is low, being of the order of about 10 nm per hour.

Consequently, it is very difficult to use CMP to erase surface defects left on the surface of an SiC wafer by successive diamond polishing operations.

It thus appears that polishing SiC wafers in order to obtain planeness and roughness that are compatible with subsequent molecular bonding presents substantial difficulties.

It is also known to polish a surface by implementing a mixture comprising abrasive particles mixed in a solution including a species that is chemically reactive with the surface to be polished.

Such polishing, which is known as tribo-chemical polishing, combines the mechanical action of friction from abrasive particles with the chemical action of the reactive species, making it possible in particular to dissolve at least some of the atoms that have come from the surface being abraded by the abrasive particles.

A description of an application of that type of polishing to treating a diamond surface is to be found in the article "Diversity and feasibility of direct bonding: survey of a dedicated optical technology" by Haisma et al., Applied Optics, Vol. 33, No. 7, March 1, 1994.

That type of polishing thus makes it possible to obtain surface roughnesses that are very small for a material that is very hard such as diamond. In addition, it does not generate the above-mentioned defects associated with methods of the type described in document US 5 895 583.

Returning to the context of the present invention, a tribo-chemical polishing technique could indeed be devised for polishing the surfaces of SiC wafers.

In particular, the specific teaching of the above-mentioned article by Haisma et al. might be transposed by using a mixture of (abrasive) diamond particles and a solution of (chemically active) silica to polish the surface of an SiC wafer.

However, such a transposition has not yet been envisaged.

Differences between the respective natures of diamond and of SiC constitute a particular obstacle to

such transposition. Specifically, as mentioned above, SiC possesses an oriented crystal structure, and the teaching obtained concerning diamond is as a result not, a priori, transposable in any way to an SiC surface.

Even if such a transposition were to be envisaged, the conditions for implementing such polishing on an SiC wafer would remain to be defined.

Thus, in general manner, it would be advantageous to be able to implement tribo-chemical polishing with an abrasive based on diamond particles in suspension in a solution, for use on wafers of materials of different types, so as to obtain desired roughness for the wafer.

OBJECT AND SUMMARY OF THE INVENTION

The object of the invention is to make it possible to overcome the drawbacks and limitations mentioned above in reference to known techniques for polishing SiC surfaces, while obtaining the advantages of tribo-chemical polishing when applying the treatment to the surface of an SiC wafer.

In order to achieve this object, the invention provides a method of polishing a wafer of material, the method implementing at least one step of polishing with an abrasive based on diamond particles in suspension in a solution, wherein the abrasive mixture used implements diamond particles and silica particles with a diamond/silica volume ratio that is controlled to obtain desired roughness for the wafer.

Preferred, but non-limiting aspects of the method of the invention, are as follows:

- the material is a polar material;
- the material is a semiconductor material;
- the material is silicon carbide;
- said controlled volume ratio lies in the range 0.29 to 0.35;
- said controlled volume ratio lies in the range 0.3 to 0.33;

- polishing is performed with a colloidal silica of the Syton W30 type and diamond having a grain size of about 0.75 microns (μm);

- polishing is performed with a polishing head rotating at 50 revolutions per minute (rpm) and a polishing turntable likewise rotating at 50 rpm;

- the polishing head is pressed with a force of about 10 decanewtons (daN);

- the polishing is performed for a duration of about 1 hour (h);

- the polishing is performed with a polishing cloth of the IC1000 or IC1400 type;

- the polishing is performed on the Si face of the wafer;

- the polishing is performed on the C face of the wafer; and

- the polishing includes final cleaning for avoiding crystallization of abrasive agents on the surface.

BRIEF DESCRIPTION OF THE DRAWING

Other aspects, objects, and advantages of the invention appear more clearly on reading the following description made with reference to the graph in the sole figure which shows how roughness varies after tribo-chemical polishing of the surface of a wafer of silicon carbide as a function of the type of diamond/silica mixture used for polishing.

MORE DETAILED DESCRIPTION

With reference to the sole figure, it can be seen how the roughness of the surface of an SiC wafer varies after tribo-chemical polishing implemented using a mixture comprising abrasive diamond particles mixed in a silica solution.

The diamond concerned is synthetic polycrystalline diamond. The diamond particles may have a grain size of about 0.75 μm, in particular.

The silica may be a colloidal silica of the Syton W30 type.

Polishing was implemented using a rotary polishing turntable having a likewise rotary polishing head applied thereagainst, the respective rotations of the turntable and of the head being performed about parallel axes.

The rates of rotation may be about 50 rpm for the turntable and for the head (the turntable and the head having the same speed of rotation).

More generally, the rate of rotation may lie in the range 10 rpm to 100 rpm.

The turntable was covered in a polishing cloth, e.g. cloth of the IC1000 or IC1400 type (available, for example, from the supplier Rodel).

The wafer for polishing was maintained between the turntable and the head, being driven by the rotation of the head which was pressed against the rear face of the wafer (the face of the wafer that is exposed to the cloth carried by the turntable being the face that is to be polished).

The diamond and silica mixture was injected continuously between the polishing turntable covered in its abrasive cloth and the surface of the wafer to be polished.

The head was pressed down with a force of about 10 daN, so as to press the SiC wafer for polishing against the abrasive cloth. More broadly, said pressure may lie in the range 5 daN to 50 daN.

Optionally, the polishing head could be mounted on an arm enabling a sweeping motion to be imparted to the head over the cloth during polishing.

The specific type of SiC wafer used was an SiC wafer of the type "4H - 8° off".

In the example illustrated by the figure, the surface polished was the silicon face.

Nevertheless polishing could equally well be applied to the carbon face.

The graph of the sole figure plots roughness up the ordinate axis as obtained after polishing under the conditions specified below for a duration of about 1 h.

The roughness is expressed in rms angstrom (Å) values as measured by an optical profilometer.

Values of the diamond/silica volume ratio, written "D/S ratio", are plotted along the abscissa axis.

The graph comprises in particular four reference points which correspond to the pairs of points (roughness, D/S ratio) given in the table below (the table also comprises an additional pair that is not plotted on the graph:

D/S	Roughness (Å rms)
0.25	3.2
0.3	2
0.33	2
0.5	3.4
1	3.1

It is also specified that the initial roughness of the wafer was 4 Å rms, said roughness likewise being measured by an optical profilometer.

From this curve, it can be seen that the roughness that was obtained was strongly influenced by the D/S ratio.

The first aspect of the invention is thus to identify and characterize the influence of the D/S ratio on the final roughness of the SiC wafer: there exists a local roughness minimum over a range of values for this D/S ratio, with roughness increasing on either side for smaller and for greater values of the D/S ratio.

More precisely, it can be seen that particularly low roughness (about 2 Å rms) is obtained for the D/S ratio lying in the range 0.29 to 0.35, and more precisely still

that the lowest roughness is obtained for a D/S ratio lying in the range 0.3 to 0.33.

It thus appears that implementing tribo-chemical polishing on an SiC surface can produce advantageous effects.

Beyond that, it can be seen that the roughness obtained after polishing can be controlled by means of the D/S ratio.

It is preferable to select this ratio close to the above-mentioned values (range 0.29 to 0.35, and more particularly preferred range 0.3 to 0.33), in order to obtain particularly small roughness, of about 2 Å rms.

In particularly advantageous manner, the invention thus makes it possible to obtain very smooth surface states for SiC wafers.

It should also be observed that the invention makes it possible to planarize SiC wafers without running the risk of damaging them (in this respect the invention differs from methods such as that described in document US 5 895 583).

In fact, it has been found that the method of the invention is effective in erasing the surface topology of the wafer, while greatly restricting the removal of material (which remains typically less than 2 μm): surfaces polished in accordance with the invention and observed with an optical profilometer are free from scratches.

The fact that the resulting surface roughness is excellent provides excellent preparation for subsequent steps (for example in order to perform ultrafinishing polishing by using pure colloidal silica, by using a beam of ion aggregates, in order to achieve molecular bonding, or in order to perform epitaxial growth).

It has also been observed that a cleaning step performed after polishing implemented in accordance with the invention is particularly advantageous in order to avoid crystallization of abrasive agents on the surface.

Such cleaning can be performed by rinsing the surface of the wafer with deionized water, and then cleaning said surface in a bath of HF.

The planarizing of such SiC surfaces is important, for example in the context of recycling the negatives that result from methods of transferring layers, in which the thin layer is detached from a supporting substrate.

In such methods, a portion of the support used for transferring a thin layer remains and can advantageously be recycled, providing its surface state is treated appropriately.

It is also specified that although the particular example described with reference to the sole figure relates to a single crystal SiC wafer of the 4H polytype, and although it is the Si face that was polished, the method of the invention is applicable to other types of SiC wafer (e.g. single crystal SiC of 6H or 3C polytype), and the method can also be applied to the C face of the wafer. The conditions in which the method is implemented (the abrasive cloth selected, ...) can be adapted in this respect.

It is specified that in general manner the invention can be implemented on materials that are not disoriented (in particular on materials that are polar and semiconductive).

It is also possible to implement the invention on materials that are disoriented.

In a variant, the polishing device can be integrated in a system for in situ reviving, enabling the polishing cloth to be regenerated since it can become flattened during polishing, thereby enabling the cloth to retain all of its qualities.

WHAT IS CLAIMED IS:

1/ A method of polishing a wafer of material, the method implementing at least one step of polishing with an abrasive based on diamond particles in suspension in a solution, wherein the abrasive mixture used implements diamond particles and silica particles with a diamond/silica volume ratio that is controlled to obtain desired roughness for the wafer.

2/ A method according to claim 1, wherein the material is a polar material.

3/ A method according to claim 2, wherein the material is a semiconductor material.

4/ A method according to claim 3, wherein the material is silicon carbide.

5/ The method according to claim 3, wherein said controlled volume ratio lies in the range 0.29 to 0.35.

6/ The method according to claim 5, wherein said controlled volume ratio lies in the range 0.3 to 0.33.

7/ The method according to claim 3, wherein polishing is performed with a colloidal silica of the Syton W30 type and diamond having a grain size of about 0.75 μm.

8/ A method according to claim 7, wherein polishing is performed with a polishing head rotating at 50 rpm and a polishing turntable likewise rotating at 50 rpm.

9/ A method according to claim 8, wherein the polishing head is pressed with a force of about 10 daN.

10/ A method according to claim 7, wherein the polishing is performed for a duration of about 1 hour.

11/ A method according to claim 7, wherein the polishing is performed with a polishing cloth of the IC1000 or IC1400 type.

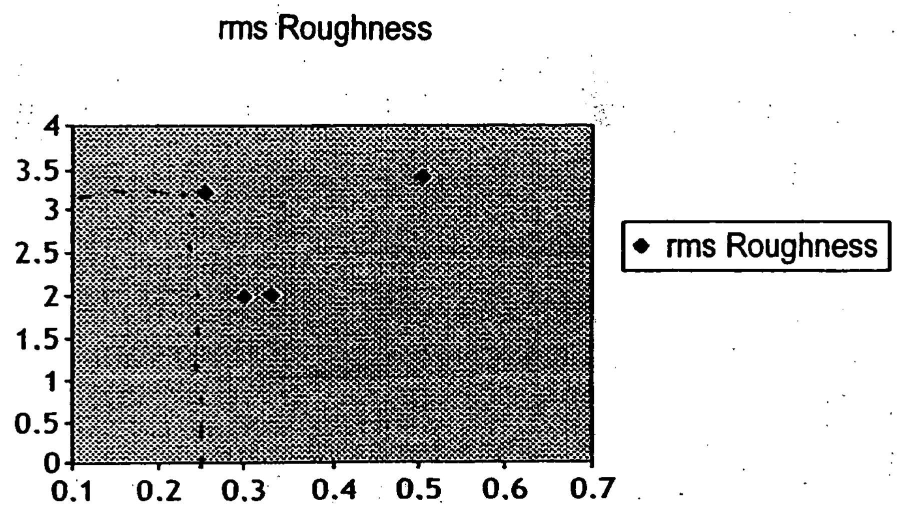
12/ A method according to claim 4, wherein the polishing is performed on the Si face of the wafer.

13/ A method according to claim 4, wherein the polishing is performed on the C face of the wafer.

14/ A method according to claim 1, wherein the polishing includes final cleaning for avoiding crystallization of abrasive agents on the surface.

ABSTRACT

The invention relates to a method of polishing a wafer of material, the method implementing at least one step of polishing with an abrasive based on diamond particles in suspension in a solution, wherein the abrasive mixture used implements diamond particles and silica particles with a diamond/silica volume ratio that is controlled to obtain desired roughness for the wafer.



D/S	rms Roughness
0.25	3.2
0.33	2
0,3	2
0.5	3.4
1	3.1

4717-6888

A METHOD OF POLISHING A WAFER OF MATERIAL

The present invention relates in general manner to treating semiconductor materials for use in microelectronic and/or optoelectronic applications.

More precisely, the invention relates to a method of polishing a wafer of material, implementing at least one polishing step using an abrasive based on diamond particles in suspension in a solution.

The invention also relates to multilayer structures obtained by bonding together two or more wafers, at least one of the wafers being a wafer of material that has been polished by such a method.

The invention may be applied in particular:

- either to wafers of material purchased directly in the trade and having surface properties that are not compatible with molecular bonding;
- or else as surface reconditioning treatment after removal and transfer of a thin layer.

BACKGROUND OF THE INVENTION

It is specified that the materials concerned by the invention are preferably polar materials.

Polar materials are defined as being materials made up of different types of atom, and presenting, when the material is in wafer form, a face with which a first type of atom is flush, while the opposite face of the wafer has a second type of atom flush therewith.

The materials may also be semiconductor materials.

Thus, for example, semiconductor polar materials include SiC, GaN, and AlN, for example.

The description given below of an implementation of the invention relates to a particular one of these materials: SiC.

Methods of the above-mentioned type are already known.

Such methods should enable a silicon carbide surface to be obtained which presents, simultaneously:

- good planeness. This is because such wafers of silicon carbide are typically used subsequently for bonding to another wafer by molecular bonding. It is important that the two surfaces which are brought together to achieve such molecular bonding to be perfectly plane - typically these surfaces should present departures from planeness that do not exceed values of the order of few microns;

- roughness that is small as possible. This second objective is also necessary in order to be able to achieve molecular bonding. In semiconductor material applications of the type mentioned in the beginning of the present patent application, it is typically desired to obtain surface roughnesses not exceeding a value of about 0.5 nanometers (nm) in root mean square mean (rms) value.

A specific constraint associated with silicon carbide (SiC) is that the material presents extremely high mechanical hardness.

In addition, the crystal structure of this material is anisotropic and oriented. Amongst other things, this means that the two opposite faces of an SiC wafer do not present the same crystal structure, one of the faces presenting silicon atoms while the opposite face presents carbon atoms.

These two characteristics make polishing SiC wafers extremely difficult, particularly when qualities of planeness and roughness such as those mentioned above are desired.

As mentioned above, methods are known of the type mentioned in the beginning of this specification which make use of at least one step of polishing the surface of an SiC wafer by means of a diamond abrasive (i.e. an abrasive based on diamond particles in suspension in a liquid).

Such polishing generally makes it possible to obtain surfaces with good planeness.

Nevertheless, the use of diamond particles leads to damage to the polished SiC surface.

Because of friction on the SiC surface, abrasive diamond particles generate crystal defects in a zone of the SiC wafer which becomes work-hardened due to the polishing.

It is then necessary to proceed with successive polishing operations using diamond particles of decreasing diameter so as to eliminate in succession the work-hardened zones as generated by each preceding polishing step.

An example of such a method is to be found in US patent document No. 5 895 583.

After the successive mechanical polishing steps, it is also necessary to perform ionic surface etching in order to eliminate the few hundreds of nm of surface thickness left defective due to the last polishing operation.

In addition, at the end of polishing operations of those types, scratches are still to be observed in the surface of the SiC wafer.

Such scratches must be eliminated by an additional step of chemical and mechanical polishing (CMP).

With SiC, such CMP polishing is difficult to implement since the polished surfaces present low chemical reactivity with respect to this type of polishing (in particular when compared with the materials that are usually polished by CMP, such as silicon, GaAs, or InP).

As a result, during the final operation of CMP polishing, the removal rate from the surface to be treated is low, being of the order of about 10 nm per hour.

Consequently, it is very difficult to use CMP to erase surface defects left on the surface of an SiC wafer by successive diamond polishing operations.

It thus appears that polishing SiC wafers in order to obtain planeness and roughness that are compatible with subsequent molecular bonding presents substantial difficulties.

It is also known to polish a surface by implementing a mixture comprising abrasive particles mixed in a solution including a species that is chemically reactive with the surface to be polished.

Such polishing, which is known as tribo-chemical polishing, combines the mechanical action of friction from abrasive particles with the chemical action of the reactive species, making it possible in particular to dissolve at least some of the atoms that have come from the surface being abraded by the abrasive particles.

A description of an application of that type of polishing to treating a diamond surface is to be found in the article "Diversity and feasibility of direct bonding: survey of a dedicated optical technology" by Haisma et al., Applied Optics, Vol. 33, No. 7, March 1, 1994.

That type of polishing thus makes it possible to obtain surface roughnesses that are very small for a material that is very hard such as diamond. In addition, it does not generate the above-mentioned defects associated with methods of the type described in document US 5 895 583.

Returning to the context of the present invention, a tribo-chemical polishing technique could indeed be devised for polishing the surfaces of SiC wafers.

In particular, the specific teaching of the above-mentioned article by Haisma et al. might be transposed by using a mixture of (abrasive) diamond particles and a solution of (chemically active) silica to polish the surface of an SiC wafer.

However, such a transposition has not yet been envisaged.

Differences between the respective natures of diamond and of SiC constitute a particular obstacle to

such transposition. Specifically, as mentioned above, SiC possesses an oriented crystal structure, and the teaching obtained concerning diamond is as a result not, a priori, transposable in any way to an SiC surface.

Even if such a transposition were to be envisaged, the conditions for implementing such polishing on an SiC wafer would remain to be defined.

Thus, in general manner, it would be advantageous to be able to implement tribo-chemical polishing with an abrasive based on diamond particles in suspension in a solution, for use on wafers of materials of different types, so as to obtain desired roughness for the wafer.

OBJECT AND SUMMARY OF THE INVENTION

The object of the invention is to make it possible to overcome the drawbacks and limitations mentioned above in reference to known techniques for polishing SiC surfaces, while obtaining the advantages of tribo-chemical polishing when applying the treatment to the surface of an SiC wafer.

In order to achieve this object, the invention provides a method of polishing a wafer of material, the method implementing at least one step of polishing with an abrasive based on diamond particles in suspension in a solution, wherein the abrasive mixture used implements diamond particles and silica particles with a diamond/silica volume ratio that is controlled to obtain desired roughness for the wafer.

Preferred, but non-limiting aspects of the method of the invention, are as follows:

- the material is a polar material;
- the material is a semiconductor material;
- the material is silicon carbide;
- said controlled volume ratio lies in the range 0.29 to 0.35;
- said controlled volume ratio lies in the range 0.3 to 0.33;

- polishing is performed with a colloidal silica of the Syton W30 type and diamond having a grain size of about 0.75 microns (μm);
- polishing is performed with a polishing head rotating at 50 revolutions per minute (rpm) and a polishing turntable likewise rotating at 50 rpm;
- the polishing head is pressed with a force of about 10 decanewtons (daN);
- the polishing is performed for a duration of about 1 hour (h);
- the polishing is performed with a polishing cloth of the IC1000 or IC1400 type;
- the polishing is performed on the Si face of the wafer;
- the polishing is performed on the C face of the wafer; and
- the polishing includes final cleaning for avoiding crystallization of abrasive agents on the surface.

BRIEF DESCRIPTION OF THE DRAWING

Other aspects, objects, and advantages of the invention appear more clearly on reading the following description made with reference to the graph in the sole figure which shows how roughness varies after tribo-chemical polishing of the surface of a wafer of silicon carbide as a function of the type of diamond/silica mixture used for polishing.

MORE DETAILED DESCRIPTION

With reference to the sole figure, it can be seen how the roughness of the surface of an SiC wafer varies after tribo-chemical polishing implemented using a mixture comprising abrasive diamond particles mixed in a silica solution.

The diamond concerned is synthetic polycrystalline diamond. The diamond particles may have a grain size of about 0.75 μm, in particular.

The silica may be a colloidal silica of the Syton W30 type.

Polishing was implemented using a rotary polishing turntable having a likewise rotary polishing head applied thereagainst, the respective rotations of the turntable and of the head being performed about parallel axes.

The rates of rotation may be about 50 rpm for the turntable and for the head (the turntable and the head having the same speed of rotation).

More generally, the rate of rotation may lie in the range 10 rpm to 100 rpm.

The turntable was covered in a polishing cloth, e.g. cloth of the IC1000 or IC1400 type (available, for example, from the supplier Rodel).

The wafer for polishing was maintained between the turntable and the head, being driven by the rotation of the head which was pressed against the rear face of the wafer (the face of the wafer that is exposed to the cloth carried by the turntable being the face that is to be polished).

The diamond and silica mixture was injected continuously between the polishing turntable covered in its abrasive cloth and the surface of the wafer to be polished.

The head was pressed down with a force of about 10 daN, so as to press the SiC wafer for polishing against the abrasive cloth. More broadly, said pressure may lie in the range 5 daN to 50 daN.

Optionally, the polishing head could be mounted on an arm enabling a sweeping motion to be imparted to the head over the cloth during polishing.

The specific type of SiC wafer used was an SiC wafer of the type "4H - 8° off".

In the example illustrated by the figure, the surface polished was the silicon face.

Nevertheless polishing could equally well be applied to the carbon face.

The graph of the sole figure plots roughness up the ordinate axis as obtained after polishing under the conditions specified below for a duration of about 1 h.

The roughness is expressed in rms angstrom (Å) values as measured by an optical profilometer.

Values of the diamond/silica volume ratio, written "D/S ratio", are plotted along the abscissa axis.

The graph comprises in particular four reference points which correspond to the pairs of points (roughness, D/S ratio) given in the table below (the table also comprises an additional pair that is not plotted on the graph:

D/S	Roughness (Å rms)
0.25	3.2
0.3	2
0.33	2
0.5	3.4
1	3.1

It is also specified that the initial roughness of the wafer was 4 Å rms, said roughness likewise being measured by an optical profilometer.

From this curve, it can be seen that the roughness that was obtained was strongly influenced by the D/S ratio.

The first aspect of the invention is thus to identify and characterize the influence of the D/S ratio on the final roughness of the SiC wafer: there exists a local roughness minimum over a range of values for this D/S ratio, with roughness increasing on either side for smaller and for greater values of the D/S ratio.

More precisely, it can be seen that particularly low roughness (about 2 Å rms) is obtained for the D/S ratio lying in the range 0.29 to 0.35, and more precisely still

that the lowest roughness is obtained for a D/S ratio lying in the range 0.3 to 0.33.

It thus appears that implementing tribo-chemical polishing on an SiC surface can produce advantageous effects.

Beyond that, it can be seen that the roughness obtained after polishing can be controlled by means of the D/S ratio.

It is preferable to select this ratio close to the above-mentioned values (range 0.29 to 0.35, and more particularly preferred range 0.3 to 0.33), in order to obtain particularly small roughness, of about 2 Å rms.

In particularly advantageous manner, the invention thus makes it possible to obtain very smooth surface states for SiC wafers.

It should also be observed that the invention makes it possible to planarize SiC wafers without running the risk of damaging them (in this respect the invention differs from methods such as that described in document US 5 895 583).

In fact, it has been found that the method of the invention is effective in erasing the surface topology of the wafer, while greatly restricting the removal of material (which remains typically less than 2 μm): surfaces polished in accordance with the invention and observed with an optical profilometer are free from scratches.

The fact that the resulting surface roughness is excellent provides excellent preparation for subsequent steps (for example in order to perform ultrafinishing polishing by using pure colloidal silica, by using a beam of ion aggregates, in order to achieve molecular bonding, or in order to perform epitaxial growth).

It has also been observed that a cleaning step performed after polishing implemented in accordance with the invention is particularly advantageous in order to avoid crystallization of abrasive agents on the surface.

Such cleaning can be performed by rinsing the surface of the wafer with deionized water, and then cleaning said surface in a bath of HF.

The planarizing of such SiC surfaces is important, for example in the context of recycling the negatives that result from methods of transferring layers, in which the thin layer is detached from a supporting substrate.

In such methods, a portion of the support used for transferring a thin layer remains and can advantageously be recycled, providing its surface state is treated appropriately.

It is also specified that although the particular example described with reference to the sole figure relates to a single crystal SiC wafer of the 4H polytype, and although it is the Si face that was polished, the method of the invention is applicable to other types of SiC wafer (e.g. single crystal SiC of 6H or 3C polytype), and the method can also be applied to the C face of the wafer. The conditions in which the method is implemented (the abrasive cloth selected, ...) can be adapted in this respect.

It is specified that in general manner the invention can be implemented on materials that are not disoriented (in particular on materials that are polar and semiconductive).

It is also possible to implement the invention on materials that are disoriented.

In a variant, the polishing device can be integrated in a system for in situ reviving, enabling the polishing cloth to be regenerated since it can become flattened during polishing, thereby enabling the cloth to retain all of its qualities.

WHAT IS CLAIMED IS:

1/ A method of polishing a wafer of material, the method implementing at least one step of polishing with an abrasive based on diamond particles in suspension in a solution, wherein the abrasive mixture used implements diamond particles and silica particles with a diamond/silica volume ratio that is controlled to obtain desired roughness for the wafer.

2/ A method according to claim 1, wherein the material is a polar material.

3/ A method according to claim 2, wherein the material is a semiconductor material.

4/ A method according to claim 3, wherein the material is silicon carbide.

5/ The method according to claim 3, wherein said controlled volume ratio lies in the range 0.29 to 0.35.

6/ The method according to claim 5, wherein said controlled volume ratio lies in the range 0.3 to 0.33.

7/ The method according to claim 3, wherein polishing is performed with a colloidal silica of the Syton W30 type and diamond having a grain size of about 0.75 µm.

8/ A method according to claim 7, wherein polishing is performed with a polishing head rotating at 50 rpm and a polishing turntable likewise rotating at 50 rpm.

9/ A method according to claim 8, wherein the polishing head is pressed with a force of about 10 daN.

10/ A method according to claim 7, wherein the polishing is performed for a duration of about 1 hour.

11/ A method according to claim 7, wherein the polishing is performed with a polishing cloth of the IC1000 or IC1400 type.

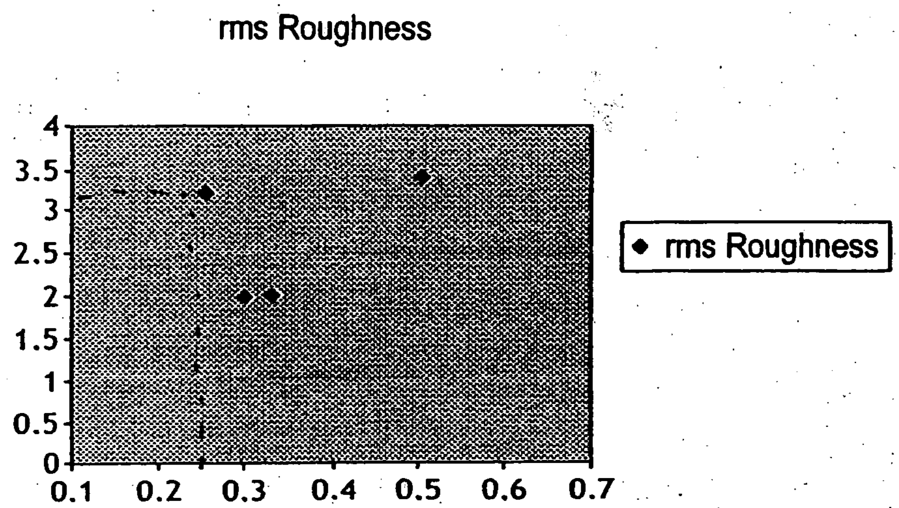
12/ A method according to claim 4, wherein the polishing is performed on the Si face of the wafer.

13/ A method according to claim 4, wherein the polishing is performed on the C face of the wafer.

14/ A method according to claim 1, wherein the polishing includes final cleaning for avoiding crystallization of abrasive agents on the surface.

A B S T R A C T

The invention relates to a method of polishing a wafer of material, the method implementing at least one step of polishing with an abrasive based on diamond particles in suspension in a solution, wherein the abrasive mixture used implements diamond particles and silica particles with a diamond/silica volume ratio that is controlled to obtain desired roughness for the wafer.



D/S	rms Roughness
0.25	3.2
0.33	2
0,3	2
0.5	3.4
1	3.1